Case Study 164

Variable speed drives on a flour mill extract fan

Flour milling using high efficiency motors

A number of variable speed drives (VSDs) had been installed previously in the plant for the primary purpose of controlling production output and quality. As these installations had proved to be extremely reliable, and following the detailed recommendation of an energy survey of the site, it was decided to install a VSD on a dust extract fan motor. This would control the airflow by varying the speed and hence reduce energy consumption.

The energy utilisation section of RHM Research and Engineering Ltd carried out monitoring of the electrical performance of the dust extract fan motors prior to and following installation of the VSD. The VSD was connected to the fan motor designated M79. Further independent measurements have now been undertaken to confirm the savings which were being achieved.

Case Study Objective

To demonstrate the cost and energy savings which can be achieved by using variable speed drives to control the speed of large extract fans.

Potential Users

Any user of fans where varying rates of extract/exhaust can be tolerated.

Investment Cost

£12,900 (1992 prices).

Savings Achieved

114,342 kWh (413 GJ) worth £4,900/year at an average of 93% of full speed (1992 prices).

Payback Period

2.6 years - under automatic speed control (93% of full speed).

1 year - if run at minimum speed possible (80% of full speed).

Case Study Summary

Dust is extracted from the flour milling operations of the Rank Hovis Trafford mill by up to four large (75 kW) electric motor driven fans. Each fan motor was originally controlled by a star/delta starter to limit the starting current. Once operating, the motors were left to run at full speed, with airflow control being achieved by varying the position of the dampers in the ductwork from the individual cyclones.

Host Organisation

Rank Hovis Ltd
Trafford Mill, Trafford Park
Manchester

Equipment Manufacturer & Supplier

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Mr G Newton

Monitoring Organisation

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Mr D M Lowther

There are other suppliers of similar energy efficiency equipment in the market. Please consult your supply directories or contact ETSU who may be able to provide you with more details on request.

"They were able to demonstrate immediate revenue savings which we continue to enjoy today"

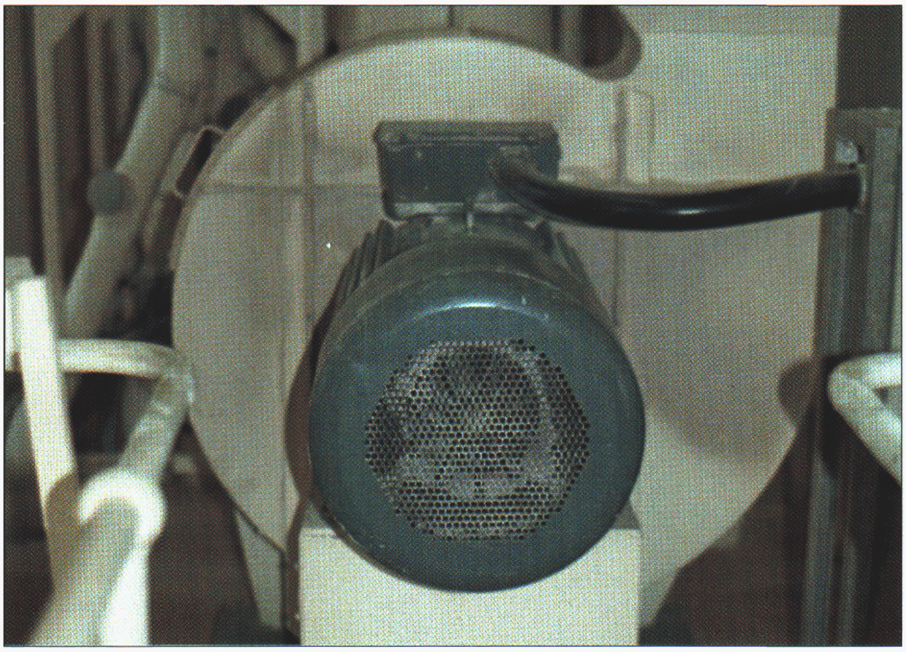
BEST PRACTICE PROGRAMME

ENERGY EFFICIENCY

Project Background

Rank Hovis McDougall plc (RHM) have an ongoing commitment to energy conservation and efficient use of resources. Through their Research and Engineering Company a number of energy surveys have been carried out. As a result, a policy has been developed of using only high efficiency motors for drives greater than 5.5 kW.

At the Trafford Park flour mill operated by Rank Hovis Ltd (an RHM company), both white and brown flour are produced on a continuous production cycle which runs for up to eight weeks without stopping. Milling of the grain to produce flour creates a significant amount of dust which has to be contained within the plant. This is achieved by a number of collectors and cyclones, with the system balance being maintained by a series of large (75 kW) electric motor driven fans which operate continuously during the production cycle. The annual running cost of each of these fans is approximately £25,000.

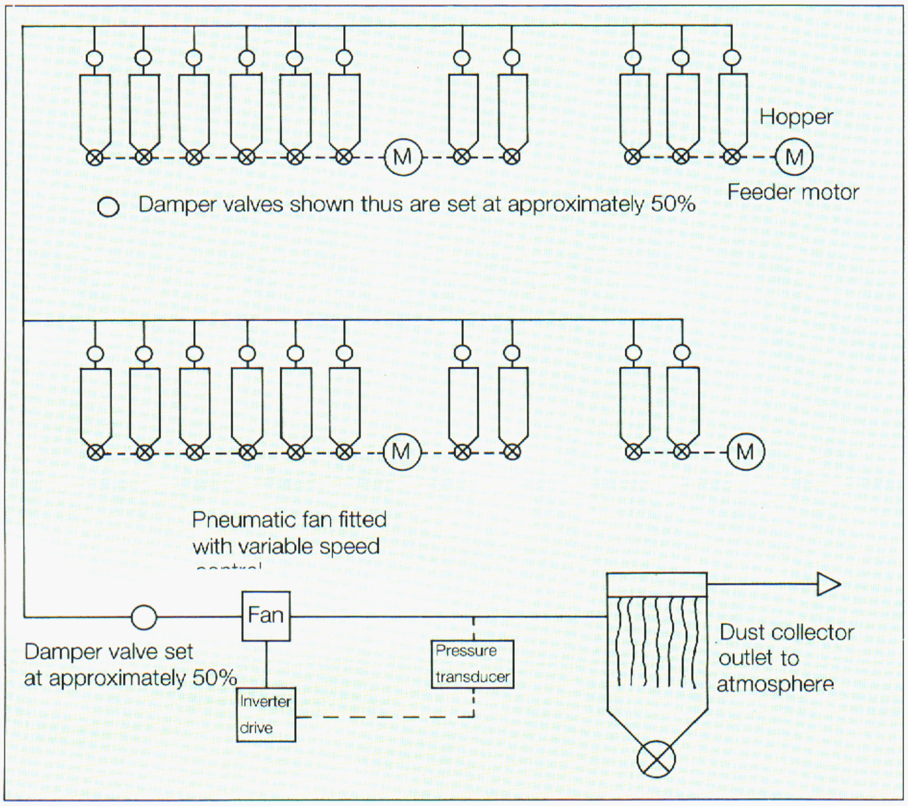


Fan and fan motor

Following an energy survey of the flour mill it was recommended that control of the dust extract fan airflow should be changed from the use of a mechanical damper in the duct, which wastes energy, to automatic speed control of the fan motor using a VSD. As the motor speed is reduced by the VSD to meet lower airflow requirements, so the power usage is reduced but by a significantly greater amount. The power consumed by the fan is proportional to the speed cubed. As an example, if the speed is reduced by 20% the power consumption will fall by around 50%, ($0.8 \times 0.8 \times 0.8 = 0.512$). It can be seen therefore that for a small reduction in speed a significant reduction in power can be achieved.

RHM also carried out some test monitoring on one of the large dust extract fans to measure the potential for saving power. This showed that the fan motor speed could be reduced to a minimum of 80% of its rated speed. It was therefore decided to install a VSD to control the motor speed and thereby realise the potential energy savings. The installation of the VSD had to be carried out in the short break between production cycles of not more than 24 hours. This was achieved successfully.

The original flow control system was maintained as a standby to ensure security of production in case of breakdown. However, with the exception of the VSD panel cooling fan which failed during the warranty period, the system has operated reliably in the three years since its installation. The panel cooling fan was replaced with eight smaller units.



Flour mill dust extract system

Energy Savings

Simultaneous independent monitoring of two similar dust extract motors was undertaken over a period of six weeks. One motor (M79) had its speed controlled by a VSD, the other (M78) ran at a fixed speed but was fitted with an electronic soft start unit. When the VSD on M79 was set to run at full speed the power consumed matched the consumption of the unmodified motor M78. Over the six week period the average power used by M78 was 70 kW compared with the 60 kW consumed by M79, a saving of 10 kW.

This average power saving of 14.3% corresponds to an average motor speed of 95%. During the monitoring period the maximum power saving was 17%, corresponding to 94% of full speed. When the average power saving is extrapolated over the annual running period the savings are 82,320 kWh/year.

These savings are lower than demonstrated by earlier measurements made by RHM. An investigation revealed that during most of the monitoring period the speed of the VSD had not been controlled by the pressure transducer but had been overridden by the operating staff to 95% of full speed. The monitoring performed by RHM showed that the annual savings when the VSD speed is controlled automatically would be 114,342 kWh/year.

In order to achieve the full savings, steps have been taken to make operatives aware of the financial advantages that can be achieved by allowing the system to operate in fully automatic mode. In future, awareness discussions on plant operation will include a section on energy efficiency opportunities.

Economic Analysis

Under automatic control the measurements show a saving of 20% or 114,342 kWh/year. These savings, worth £4,900/year, give a simple payback period of 2.6 years on the investment of £12,900. For most of the six week monitoring period, the savings were not as high as previously measured due to the overriding of the automatic speed control. Under manual control the annual savings of 82,320 kWh give a payback of 3.6 years.

The degree of speed turndown obviously has a significant impact on the savings and payback. The table illustrates how a relatively small reduction in speed can produce higher savings and shorter paybacks.

Speed (%)	Power (kW)	Saving (kWh)	Payback (years)
100	71.0	-	-
98	66.8	34,410	8.72
96	62.8	67,338	4.45
94	59.0	99,031	3.03
92	55.3	129,325	2.32
90	51.8	158,384	1.89
88	48.4	186,208	1.61
86	45.2	212,715	1.41
84	42.1	238,069	1.26
82	39.1	262,189	1.14
80	36.4	285,239	1.05

The fan draws air from several ducts and in order to balance the flows, dampers have been fitted. For process reasons, not all dampers can be fully opened. On sites where dampers could be fully opened the motor speed could be reduced further with a corresponding increase in savings.

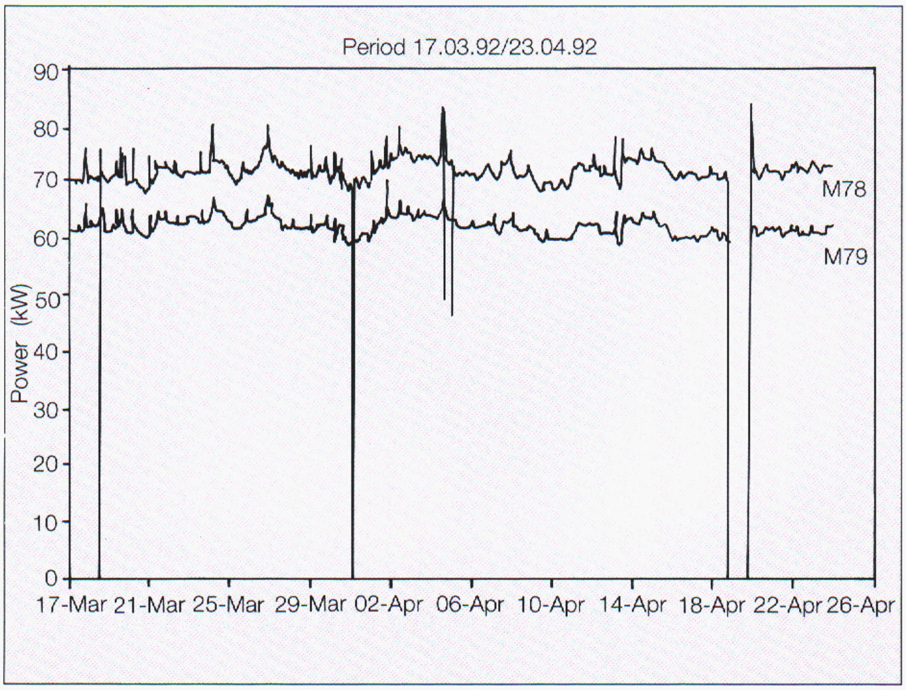
As motor M79 is a high efficiency type, the power factor near full load was already over 0.9. As a result, no additional financial benefit was achieved even though the VSD fitted to motor M79 also had a high power factor.

Future Potential

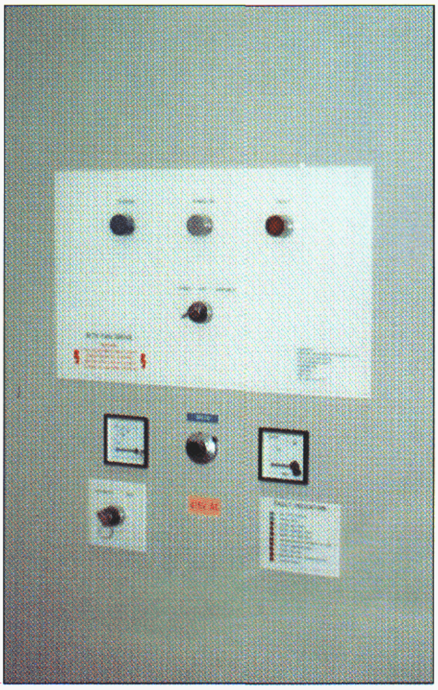
The installation of the VSD at Rank Hovis has shown that worthwhile power savings can be achieved on a large fan even with a modest reduction in speed. At sites where the dampers could be fully opened a greater speed reduction would be possible with significantly greater savings. For example, if the speed averaged 80% of full speed the savings would be worth £12,220/year.

The connection of the VSD into the control circuit of the motor is relatively straight-forward and has required minimum additional maintenance. Reliability has been very good.

There are a number of other opportunities for reducing energy consumption by installing VSD technology on the site. These will be addressed at the earliest opportunity.



Exhaust fan motors M78 and M79



Inverter control panel

Comments from RHM

This project demonstrated that the energy consumption of mill fan motor M79 could be minimised by the use of an inverter drive under automatic control. The effect of pulling too much air through the system is wasteful of energy. By varying the speed of the fan drive motor to match demand for air, significant energy savings have been made.

The use of a frequency inverter for revenue savings on this fan was suggested during an extended energy survey of the whole site. After a more detailed study, the inverter and control systems were duly fitted and commissioned. This project was managed by our own research and engineering staff who also tested the system. They were able to demonstrate immediate revenue savings which we continue to enjoy today.

The cost savings achieved have not been as high as the initial survey indicated. This is due to the reductions in electricity costs which we enjoyed as a result of the aggressive buying policy of our purchasing group. Electricity costs have, however, already started rising and the revenue savings will therefore increase.

The system has proved to be efficient and reliable.

Trafford Flour Mill

Experience with this application has lead our research and engineering department to issue an application guide which will encourage other sites within the group to install similar systems and benefit from the knowledge gained in this initial installation.

K Bootl

Mr Keith Boothman
Plant Engineering Manager
Rank Hovis McDougall

Rank Hovis McDougall (RHM)

RHM is a multi-food manufacturing group, within the Tomkins organisation, with a large number of factories throughout the UK producing brands such as Hovis flour.

Within the RHM group there is a research and engineering company which has a specialist team looking at energy efficiency opportunities on a national basis. This team has identified many areas where energy can be saved and carried out the initial monitoring which led to the installation of a VSD at the Manchester flour mill of Rank Hovis Ltd.

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FIRST PUBLISHED MAY 1993
REPRINTED AUGUST 1998